U. S. DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION
WASHINGTON 25, D. C.

TECHNICAL STANDARD ORDER

Regulations of the Administrator
Part 514

SUBJECT: Electric Tachometers. Magnetic Drag Indicator and Generator TSO-C49

Part 514—Technical Standard Orders for Aircraft Materials, Parts, Processes, and Appliances

Under section 601 of the Civil Aeronautics Act of 1938 and the delegation of authority from the Civil Aeronautics Board in §§ 3.18, 4a.31, 4b.18, 6.18, and 7.18 of the Civil Air Regulations, the Administrator of Civil Aeronautics is authorized to adopt performance standards and specifications of materials, parts, processes, and appliances used in aircraft as he may find necessary to implement provisions of the Civil Air Regulations. The Administrator adopted the Technical Standard Order system as a means to carry out this delegated authority. This system, in brief, provides for CAA-industry cooperation in the development of these performance standards, and a form of self-regulation by industry in demonstrating compliance with these standards. Since the original adoption of this part, which contains the C series TSO's, it has been found desirable to make clarifying editorial and format changes. Hence, Part 514 of the Regulations of the Administrator is being amended to provide two subparts. Subpart A contains the general requirements applicable to all Technical Standard Orders, such as "Method of Conformance," "Marking," and "Deviations." Subpart B contains the technical specifications to which a specific product must conform.

SUBPART A—GENERAL

§ 514.1 *Basis and purpose*—(a) *Basis.* Section 601 of the Civil Aeronautics Act of 1938, as amended, and §§ 3.18, 4a.31, 4b.18, 6.18, 7.18 of the Civil Air Regulations.

(b) *Purpose.* The purpose of this part is to establish minimum performance standards for aircraft materials, parts, processes, and appliances which are to be used on civil aircraft of the United States, and to prescribe the manner by which the manufacturer must show compliance with such performance standards.

§ 514.2 *Method of conformance.* A manufacturer of an aircraft material, part, process, or appliance for which standards are established in Subpart B of this part, prior to distribution for use on a civil aircraft of the United States, shall furnish a written statement of conformance certifying that the material, part, process, or appliance meets the applicable performance standards established in this part. The statement of conformance shall be signed by a person duly authorized by the manufacturer, and shall be furnished to the Chief, Aircraft Engineering Division, Office of Aviation Safety, Civil Aeronautics Administration, Washington 25, D. C.

If complaints of nonconformance with the requirements of this Order are brought to the attention of the CAA and investigation indicates that such complaints are justified, the Administrator will take appropriate action to restrict the use of the product in civil aircraft.

§ 514.3 *Marking.* Materials, parts, processes, and appliances for which a statement of conformance has been submitted, shall be legibly and permanently marked with the following information:

(a) Name and address of the manufacturer responsible for compliance,

(b) Equipment name, or type or model designation,

(c) Weight to the nearest pound and fraction thereof,

(d) Serial number and/or date of manufacture, and

(e) Applicable Technical Standard Order (TSO) number.

§ 514.4 *Deviations.* No deviation will be granted from the performance standards established in Subpart B. Requests for deviation from other requirements of this part should be addressed to the Aircraft Engineering Division, Office of Aviation Safety, Civil Aeronautics Administration, Washington 25, D. C.

§514.48 Electric tachometers: magnetic drag (indicator and generator):--TSO-C49--(a) Applicability--(1) Minimum performance standards. Minimum performance standards are hereby established for electric tachometers: magnetic drag (indicator and generator) which specifically are required to be approved for use in civil aircraft of the United States. New models of electric tachometers: magnetic drag (indicator and generators) manufactured for installation in civil aircraft on or after October 15, 1957, shall meet the standards set forth in SAE Aeronautical Standard AS-404A, "Electric Tachometer: Magnetic Drag (indicator and generator)," dated December 15, 1954.1/ Electric tachometers: magnetic drag (indicator and generator) approved by the Civil Aeronautics Administration prior to October 15, 1957, may continue to be manufactured under the provisions of their original approval.

(b) Marking. In lieu of the weight specified in paragraph (c) of §514.3, the range shall be shown.

(c) Data requirements. One copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Aircraft Engineering Division, Civil Aeronautics Administration, Washington 25, D. C., with the statement of conformance.

(d) Effective date. October 15, 1957.

1/ Copies may be obtained from the Society of Automotive Engineers, 485 Lexington Avenue, New York 17, New York.

(9/25/57)

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Society of Automotive Engineers, Inc.
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New York City

AERONAUTICAL STANDARD AS404A

ELECTRIC TACHOMETER: MAGNETIC DRAG
(Indicator and Generator)

Issued 11-1-48
Revised 12-15-54

1. PURPOSE: To specify minimum requirements for Electric Tachometers for use in aircraft, the operation of which may subject the instruments to the environmental conditions specified in Section 3.3.

2. SCOPE: This Aeronautical Standard covers magnetic drag tachometers with or without built-in synchroscopes.

3. GENERAL REQUIREMENTS:

3.1 Materials and Workmanship:

3.1.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft instruments.

3.1.2 Workmanship: Workmanship shall be consistent with high-grade aircraft instrument manufacturing practice.

3.2 Identification: The following information shall be legibly and permanently marked on the instrument or attached thereto:

a. Name of Instrument.

b. SAE Aeronautical Standard, AS 404.

c. Manufacturer's Part Number.

d. Manufacturer's serial number or date of manufacture.

e. Manufacturer's name and/or trade mark.

f. Range.

3.3 Environmental Conditions: The following conditions have been established as design requirements only. Tests shall be conducted as specified in Sections 5, 6 and 7.

3.3.1 Temperature: When installed in accordance with the instrument manufacturer's instructions, the instruments shall function over the range of ambient temperatures shown in Column A below and shall not be adversely affected by exposure to the range of temperatures shown in Column B below:

Instrument Location	A	B
Powerplant Accessory Compartment	-30 to 70C	-65 to 100C
Heated Areas (temperature controlled)	-30 to 50C	-65 to 70C

3.3.2 Humidity: The instrument shall function and shall not be adversely affected when exposed to any relative humidity in the range from 0 to 95% at a temperature of approximately 32C.

3.3.3 Altitude: The instrument shall function and shall not be adversely affected when subjected to a pressure and temperature range equivalent to -1000 to +40,000 feet standard altitude, except that the instrument temperature shall not be lower than -30C.

3.3.4 Vibration: When installed in accordance with the instrument manufacturer's instructions the units shall function and shall not be adversely affected when subjected to vibrations of the following characteristics:

Type of Component Mounting	Cycles/Minute	Amplitude	Max. Accel.
Airframe Structure-Mounted	300 - 30,000	.036"	10 g.
Shock-Mounted Panel	300 - 3,000	.020"	1.5 g.
Powerplant-Mounted	300 - 30,000	.060"	20 g.

3.4 Radio Interference: The instrument shall not be the source of objectionable interference, under operating conditions at any frequencies used on aircraft, either by radiation or feed-back, in electronic equipment installed in the same aircraft as the instrument.

4. DETAIL REQUIREMENTS:

4.1 Indicator:

4.1.1 Indication: Engine speed shall be indicated by means of one or more moving pointers or dials. Relative movement of the pointer with respect to the dial shall be clockwise for increasing RPM.

4.1.2 Dial Visibility: The pointer(s) and all dial markings shall be visible from any point within the frustum of a cone whose side makes an angle of not less than 30° with the perpendicular to the dial and whose small diameter is the aperture of the instrument case. The distance between the dial and the cover glass shall be a practical minimum and shall not exceed 0.200".

4.1.3 Dial Markings:

4.1.3.1 Finish: Unless otherwise specified, luminescent material (self-activating) shall be applied to all the pointers, all major graduations, and numerals.

4.1.3.2 Graduations: All graduations shall be multiples of 10 RPM. The increment between graduations shall not exceed 2-1/2% of full scale, above 600 RPM.

4.1.3.3 Numerals: Sufficient numerals shall be marked to identify positively and quickly all graduations.

4.1.3.4 Instrument Name: The designation "RPM", plus such other nomenclature as may be necessary, shall be legibly marked on the dial and may be of the same finish as the numerals.

4.2 Generator: The generator shall be designed to operate in either direction of rotation and in any position.

5. TEST CONDITIONS:

5.1 Atmospheric Conditions: Unless otherwise specified all tests required by this Aeronautical Standard shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury and at an ambient temperature of approximately 22C. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

5.2 Vibration (to minimize friction): Unless otherwise specified all tests for performance may be made with the instrument subjected to a vibration of 0.002 to 0.005 inch double amplitude at a frequency of 1500 to 2000 cycles per minute. The term double amplitude as used herein indicates total displacement from positive maximum to negative maximum.

5.3 Vibration Equipment: Vibration equipment shall be used which will provide frequencies and amplitudes consistent with the requirements of section 3.3.4 with the following characteristics:

5.3.1 Linear Motion Vibration: Vibration equipment for airframe structure-mounted or powerplant-mounted instruments or equipment shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the test specimen.

5.3.2 Circular Motion Vibration: Vibration equipment for shock-mounted panel instruments shall be such that a point on the instrument case will describe, in a plane inclined 45 degrees to the horizontal plane, a circle, the diameter of which is equal to the double amplitude specified.

5.4 Position: Unless otherwise specified, all tests shall be conducted with the instrument mounted in its normal operating position.

6. INDIVIDUAL PERFORMANCE REQUIREMENT: All instruments or components of such shall be subjected to whatever tests the manufacturer deems necessary to demonstrate specific compliance with this Aeronautical Standard, including the following requirements when applicable.

6.1 Indicator Tests:

6.1.1 Scale Error at Room Temperature: The tachometer indicator shall be connected to its generator and the generator operated at the shaft speeds within the ranges specified in Table I. The scale error at any speed shall not exceed the values specified in Table I, with the speeds increasing or decreasing. When the speed is held constant at any point on the scale, the pointer shall not oscillate over a range greater than 20 RPM from 600 RPM to full-scale indication.

TABLE I

SCALE ERROR

Gen. Drive Shaft Speed RPM	Correct Indicated Speed RPM	Scale Error Tolerance RPM
300 - 1400	600 - 2800	25
1500 - 2250	3000 - 4500	40

6.1.2 Dielectric: The insulation shall withstand, without any evidence of damage, an application of a sinusoidal voltage of 500 volts RMS at a commercial frequency for a minimum period of 5 seconds between any of the connector pins and any metal part of the case or electrical connector shell. The insulation resistance shall not be less than 5 megohms. On grounded components this test shall be performed prior to grounding of any leads.

6.1.3 Position Error: The change in pointer indication with change in instrument position from normal position shall not exceed 25 RPM.

7. QUALIFICATION TESTS: As many instruments as may be deemed necessary to demonstrate that all instruments will comply with the requirements of this section shall be tested in accordance with the manufacturer's recommendations.

7.1 Low Temperature: The instrument shall be subjected to -30C for three hours. The change in indication from the reading obtained at room temperature shall not exceed one percent of full scale. The instrument may be operated at 2000 RPM or half scale, whichever is higher, for a period of 10 minutes before making this scale error test. The force required to turn the generator shaft while and after it has been subjected to a temperature of minus 55C for two hours, shall not exceed 8 pound inches. No damage to the generator shall result from this test.

7.2 High Temperature: The instrument shall be subjected to a temperature of 70C for a period of three hours. The change in indication from the readings obtained at room temperature shall not exceed one percent of full scale for the range 600-2800 RPM, and shall not exceed one and one-half percent of full scale for the range from 3000 to 4500 RPM.

7.3 Extreme Temperature Exposure: The instrument shall, after alternate exposure to ambient temperatures specified in Column B of Section 3.3.1 for a period of 24 hours each and a delay of 3 hours at room temperature following completion of the exposure, meet the requirements of Section 6.1.1. During the high temperature exposure, the generator shall be operating at a shaft speed equivalent to half-scale indicator reading and shall be supplying full-rated electrical load for that speed. There shall be no evidence of damage as a result of exposure to the extreme temperatures specified herein.

7.4 Magnetic Effect: The magnetic effect of the indicator shall be determined in terms of the deflection of a free magnet, approximately 1-1/2 inches long, in a magnetic field with a horizontal intensity of 0.18 +0.01 gauss when the indicator is held in various positions on an east-west line with its nearest part 5 inches from the center of the magnet. This test shall first be made with the indicator not operating and then shall be repeated with the indicator in normal operation. The maximum deflection of the free magnet shall not exceed 2 degrees for any pointer or dial position.

7.5 Vibration: The instrument, while operating and with various pointer settings throughout the range, shall be subjected to vibrations of all frequencies within the appropriate range specified in Section 3.3.4 in order to determine if there exist any natural frequencies, of any parts, that lie within the specified range. The amplitude used may be any convenient value that does not exceed the maximum double amplitude specified in Section 3.3.4 and such as not to exceed the maximum acceleration specified in Section 3.3.4.

The instrument shall then be subjected to vibration at the appropriate maximum double amplitude specified in Section 3.3.4 at each of the above determined natural frequencies for a period of three hours. If no natural frequencies occurred in the appropriate frequency range, the appropriate frequency and amplitude for the three-hour endurance test shall be determined from the following table:

	Cycles Per Minute	Double Amplitude
Airframe Structure-Mounted	3300	.036"
Shock-Mounted Panel	3000	.010"
Powerplant-Mounted	9000	.018"

While the instrument is being vibrated, the pointer oscillation shall not exceed one percent of full scale indication. The average pointer variation during vibration shall not exceed one percent of full scale indication. After these observations have been made, the stand shall be set to the maximum double amplitude and frequency and operated for the remainder of the three-hour period with the pointer position changed every twenty to thirty minutes.

Following the three-hour vibration period the test specified for "Scale Error at Room Temperature" in Section 6.1 shall be repeated. The change in indications between this test and the initial room temperature scale error test shall not exceed one percent of full scale indication. No screws or other parts shall become loosened as a result of this test.

7.6 Humidity: The indicator and generator shall be mounted in the normal operating position and maintained at a temperature of 70 ± 2C and a relative humidity of 95 ± 5% for a period of 6 hours. After this period the heat shall be shut off and the instrument shall be allowed to cool for a period of eighteen hours in this atmosphere in which the humidity rises to 100% as the temperature decreases to not more than 38C. This complete cycle shall be conducted:

a. Five times for instruments located in uncontrolled temperature areas.

b. Once for instruments located in controlled temperature areas.

Immediately after cycling the indicator shall be subjected to the scale error test of Section 6.1.1. The change in reading between this test and the original scale error at room temperature test shall not exceed 10 RPM.

The performance of the generator shall not be adversely affected as a result of this humidity cycling.

7.7 Acceleration Endurance: The generator drive shaft and rotor shall be subject to a uniform acceleration of 400 revolutions per second per second for a period of at least five seconds. The generator shall be subjected to this acceleration for 500 applications. No damage to any part of the generator shall result from this test.